



FEATURES

32V Input Overvoltage Protection above/below the supply rails

Rail-to-Rail Input and Output Swing

Low Power: 60 μ A/Amplifier typ

Unity Gain Bandwidth:

800 kHz typ @ $V_{sy} = \pm 15$ V

550 kHz typ @ $V_{sy} = \pm 5$ V

475 kHz typ @ $V_{sy} = \pm 1.5$ V

Single-Supply Operation: 3 V to 30 V

Low Offset Voltage: 250 μ V max

High Open-Loop Gain: 120 dB typ

Unity-Gain Stable

No Phase Reversal

APPLICATIONS

Battery Monitoring

Sensor Conditioners

Portable Power Supply Control

Portable Instrumentation

GENERAL DESCRIPTION

The ADA4096 family of operational amplifier features micropower operation and rail-to-rail input and output ranges. The extremely low power requirements and guaranteed operation from 3 V to 30 V (± 1.5 V to ± 15 V) make these amplifiers perfectly suited to monitor battery usage and to control battery charging. Their dynamic performance, including 27 nV/ \sqrt{Hz} voltage noise density, recommends them for battery-powered audio applications. The amplifier can drive capacitive loads up to 200 pF without oscillation.

The ADA4096 has overvoltage protection inputs that allow the voltage input to exceed 32V above and below the supply rails without damage, glitching, or phase reversal, making the device ideal for robust industrial applications.

The ADA4096 are specified over the extended industrial ($-40^{\circ}C$ to $+125^{\circ}C$) temperature range. The dual ADA4096-2 is available in 8-lead LFCSP (2x2) and 8-lead MSOP packages.

PIN CONFIGURATIONS

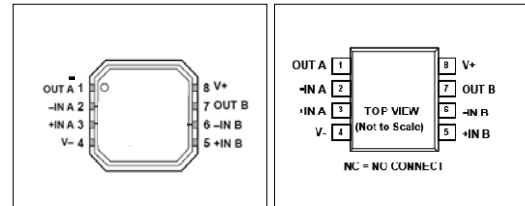


Figure 1. 8-Lead LFCSP (2x2) Figure 2. 8-Lead MSOP (RM)

Rev. PrB

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SPECIFICATIONS

ELECTRICAL CHARACTERISTICS – $V_S = \pm 15V$

$V_S = \pm 15V$, $V_{CM} = V_S/2$, $T_A = 25^\circ C$, unless otherwise specified.

Table 1.

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
INPUT CHARACTERISTICS						
Offset Voltage	V_{OS}	$-40^\circ C < T_A < +125^\circ C$		35	250	μV
Input Bias Current	I_B	$-40^\circ C < T_A < +125^\circ C$		± 3	400	μV
Input Offset Current	I_{OS}	$-40^\circ C < T_A < +125^\circ C$			± 10	nA
Input Voltage Range		$-40^\circ C < T_A < +125^\circ C$		± 0.1	± 15	nA
Common-Mode Rejection Ratio	CMRR	$-40^\circ C < T_A < +125^\circ C$ $V_{CM} = -15V$ to $+15V$	-15	95	± 3	nA
		$-40^\circ C < T_A < +125^\circ C$ $V_{CM} = -13V$ to $+13V$	75		± 3	nA
		$-40^\circ C < T_A < +125^\circ C$ $V_{CM} = -13V$ to $+13V$	95	107	± 3	nA
Large Signal Voltage Gain	A_{VO}	$-40^\circ C < T_A < +125^\circ C$ $-14.7 < V_{OUT} < +14.7, R_L = 10k\Omega$	89		± 3	nA
		$-40^\circ C < T_A < +125^\circ C$ $-11 < V_{OUT} < +11, R_L = 2k\Omega$	110	120	± 3	nA
		$-40^\circ C < T_A < +125^\circ C$ $-11 < V_{OUT} < +11, R_L = 2k\Omega$	105		± 3	nA
		$-40^\circ C < T_A < +125^\circ C$ $-11 < V_{OUT} < +11, R_L = 2k\Omega$	100	112	± 3	nA
Offset Voltage Drift	$\Delta V_{OS}/\Delta T$	$-40^\circ C < T_A < +125^\circ C$	90		± 3	nA
OUTPUT CHARACTERISTICS						
Output Voltage High	V_{OH}	$R_L = 10k\Omega$ to GND $-40^\circ C < T_A < +125^\circ C$	14.93	14.94		V
		$R_L = 2k\Omega$ to GND $-40^\circ C < T_A < +125^\circ C$	14.9			V
		$R_L = 10k\Omega$ to GND $-40^\circ C < T_A < +125^\circ C$	14.10	14.30		V
Output Voltage Low	V_{OL}	$R_L = 10k\Omega$ to GND $-40^\circ C < T_A < +125^\circ C$	12.00			V
		$R_L = 2k\Omega$ to GND $-40^\circ C < T_A < +125^\circ C$		-14.96	-14.80	V
		$R_L = 2k\Omega$ to GND $-40^\circ C < T_A < +125^\circ C$			-14.75	V
		$R_L = 2k\Omega$ to GND $-40^\circ C < T_A < +125^\circ C$		-14.75	-14.65	V
Short Circuit Limit	I_{SC}	$-40^\circ C < T_A < +125^\circ C$		± 10	-14.0	V
POWER SUPPLY						
Power Supply Rejection Ratio	PSRR	$V_S = 3V$ to $36V$ $-40^\circ C$ to $+125^\circ C$	100			dB
Supply Current/Amplifier	I_{SY}	$V_O = V_S/2$ $-40^\circ C < T_A < +125^\circ C$	90	60	75	dB
DYNAMIC PERFORMANCE						
Slew Rate	SR			0.4		$V/\mu s$
Unity Gain Crossover	UGC	$V_p = 5mV$; $R_L = 10k$; $A_v = 1$		800		kHz
Gain Bandwidth Product	GBP	$V_p = 5mV$; $R_L = 10k$; $A_v = 40dB$		800		kHz
-3dB Small Signal Bandwidth						kHz
Phase Margin	Φ_M			64		Degrees
NOISE PERFORMANCE						
Peak-to-Peak Noise	$e_{n,p-p}$	$f = 0.1$ to $10Hz$		0.4		μV p-p
Voltage Noise Density	e_n	$f = 1kHz$		27		nV/\sqrt{Hz}
Current Noise Density	i_n	$f = 1kHz$		TBD		fA/\sqrt{Hz}

ELECTRICAL CHARACTERISTICS – $V_s = \pm 5V$

$V_s = \pm 5V$, $V_{CM} = V_s/2$, $T_A = 25^\circ C$, unless otherwise specified.

Table 2.

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
INPUT CHARACTERISTICS						
Offset Voltage	V_{OS}	$-40^\circ C < T_A < +125^\circ C$		35	250	μV
Input Bias Current	I_B	$-40^\circ C < T_A < +125^\circ C$		± 10	400	μV nA
Input Offset Current	I_{OS}	$-40^\circ C < T_A < +125^\circ C$		± 1.5	± 12 ± 19	nA
Input Voltage Range		$-40^\circ C < T_A < +125^\circ C$	-5		± 2 ± 3	nA nA
Common-Mode Rejection Ratio	CMRR	$-40^\circ C < T_A < +125^\circ C$ $V_{CM} = -5V$ to $+5V$	74	86	± 5	V dB
		$-40^\circ C < T_A < +125^\circ C$ $V_{CM} = -3V$ to $+3V$	68	103		dB
		$-40^\circ C < T_A < +125^\circ C$	91			dB
		$-40^\circ C < T_A < +125^\circ C$	85			dB
Large Signal Voltage Gain	A_{VO}	$-4.8 < V_{OUT} < +4.8$, $R_L = 10k\Omega$ $-40^\circ C < T_A < +125^\circ C$	103	111		dB
		$-4.7 < V_{OUT} < +4.7$, $R_L = 2k\Omega$ $-40^\circ C < T_A < +125^\circ C$	99	103		dB
			95			dB
			88			dB
Offset Voltage Drift	$\Delta V_{OS}/\Delta T$	$-40^\circ C < T_A < +125^\circ C$		1		$\mu V/^\circ C$
OUTPUT CHARACTERISTICS						
Output Voltage High	V_{OH}	$R_L = 10k\Omega$ to GND $-40^\circ C < T_A < +125^\circ C$	4.96	4.97		V
			4.95			V
		$R_L = 2k\Omega$ to GND $-40^\circ C < T_A < +125^\circ C$	4.80	4.90		V
			4.70			V
Output Voltage Low	V_{OL}	$R_L = 10k\Omega$ to GND $-40^\circ C < T_A < +125^\circ C$		-4.98	-4.97	V
					-4.95	V
		$R_L = 2k\Omega$ to GND $-40^\circ C < T_A < +125^\circ C$		-4.90	-4.80	V
					-4.75	V
Short Circuit Limit	I_{SC}			± 10		mA
POWER SUPPLY						
Power Supply Rejection Ratio	PSRR	$V_s = 3V$ to $36V$ $-40^\circ C$ to $+125^\circ C$	100			dB
			90			dB
Supply Current/Amplifier	I_{SY}	$V_O = V_s/2$ $-40^\circ C < T_A < +125^\circ C$		47	55	μA
					75	μA
DYNAMIC PERFORMANCE						
Slew Rate	SR			0.3		V/ μs
Unity Gain Crossover	UGC	$V_p = 5mV$; $R_L = 10k$; $A_v = 1$		550		kHz
Gain Bandwidth Product	GBP	$V_p = 5mV$; $R_L = 10k$; $A_v = 40dB$		550		kHz
-3dB Small Signal Bandwidth						
Phase Margin	Φ_M			60		Degrees
NOISE PERFORMANCE						
Peak-to-Peak Noise	$e_{n\ p-p}$	$f = 0.1$ to $10Hz$		TBD		$\mu V\ p-p$
Voltage Noise Density	e_n	$f = 1kHz$		TBD		nV/ \sqrt{Hz}
Current Noise Density	i_n	$f = 1kHz$		TBD		fA/ \sqrt{Hz}

ELECTRICAL CHARACTERISTICS – VS = ±1.5V

VS = ±1.5 V, VCM = VS/2, TA = 25°C, unless otherwise specified.

Table 3.

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
INPUT CHARACTERISTICS						
Offset Voltage	V _{OS}	°0C < T _A < +125°C		35	250	μV
		–40°C < T _A < +125°C			350	μV
		–40°C < T _A < +125°C				900
Input Bias Current	I _B	–40°C < T _A < +125°C		±10	±13	nA
Input Offset Current	I _{OS}	–40°C < T _A < +125°C		±0.1	±1.5	nA
Input Voltage Range		–40°C < T _A < +125°C	–1.5		±3	V
Common-Mode Rejection Ratio	CMRR	V _{CM} = 0 V to ±1.5 V	63	77		dB
		–40°C < T _A < +125°C	58			dB
Large Signal Voltage Gain	A _{VO}	–1.4 < V _{OUT} < +1.4, R _L = 10kΩ	92	94		dB
		–40°C < T _A < +125°C	84			dB
		–1.3 < V _{OUT} < +1.3, R _L = 2kΩ	88	92		dB
		–40°C < T _A < +125°C	77			dB
Offset Voltage Drift	ΔV _{OS} /ΔT	–40°C < T _A < +125°C		1		μV/°C
OUTPUT CHARACTERISTICS						
Output Voltage High	V _{OH}	R _L = 10 kΩ to GND	1.48	1.49		V
		–40°C < T _A < +125°C	1.45			V
		R _L = 2 kΩ to GND	1.45	1.46		V
		–40°C < T _A < +125°C	1.40			V
Output Voltage Low	V _{OL}	R _L = 10 kΩ to GND		–1.49	–1.48	V
		–40°C < T _A < +125°C			–1.45	V
		R _L = 2 kΩ to GND		–1.48	–1.47	V
		–40°C < T _A < +125°C			–1.40	V
Short Circuit Limit	I _{SC}			±10		mA
POWER SUPPLY						
Power Supply Rejection Ratio	PSRR	V _S = 3 V to 36 V	100			dB
		–40°C to +125°C	90			dB
Supply Current/Amplifier	I _{SY}	V _O = V _S /2		40		μA
		–40°C < T _A < +125°C			80	μA
DYNAMIC PERFORMANCE						
Slew Rate	SR			0.25		V/μs
Unity Gain Crossover	UGC	V _p = 5mV ; R _L = 10k ; A _v = 1		475		kHz
Gain Bandwidth Product	GBP	V _p = 5mV ; R _L = 10k ; A _v = 40dB		475		kHz
–3dB Small Signal Bandwidth						kHz
Phase Margin	Φ _M			60		Degrees
NOISE PERFORMANCE						
Peak-to-Peak Noise	e _{n,p-p}	f = 0.1 to 10 Hz		TBD		μV p-p
Voltage Noise Density	e _n	f = 1 kHz		TBD		nV/√Hz
Current Noise Density	i _n	f = 1 kHz		TBD		fA/√Hz

ABSOLUTE MAXIMUM RATINGS

Table 4.

Parameter	Rating
Supply Voltage	36 V
Input Voltage	
Operating Conditions	$V^- \leq V_{in} \leq V^+$
Overvoltage Condition ¹	$V^- - 32V \leq V_{in} \leq V^+ + 32V$
Differential Input Voltage	$\pm V_{sy}$
Output Short-Circuit Duration to Gnd	Indefinite
Storage Temperature Range	-65°C to +150°C
Operating Temperature Range	-40°C to +125°C
Junction Temperature Range	-65°C to +150°C
Lead Temperature (Soldering, 60 sec)	300°C

¹ Performance specifications are not guaranteed during overvoltage conditions.

Stresses above those listed under Absolute Maximum Ratings may cause permanent damage to the device. This is a stress rating only; functional operation of the device at these or any other conditions above those indicated in the operational section of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

THERMAL RESISTANCE

θ_{JA} is specified for the worst-case conditions, that is, a device soldered in a circuit board for surface-mount packages.

Table 5. Thermal Resistance

Package Type	θ_{JA}	θ_{JC}	Unit

ESD CAUTION



ESD (electrostatic discharge) sensitive device. Charged devices and circuit boards can discharge without detection. Although this product features patented or proprietary protection circuitry, damage may occur on devices subjected to high energy ESD. Therefore, proper ESD precautions should be taken to avoid performance degradation or loss of functionality.